

the flywheel diode 62. Since the preset period of the timer circuit 67 is longer than the time constant of the field winding 5, an average value of the field current becomes small and power generation is controlled to the amount to maintain the driving of the main power supply circuit 63. Thereby, charging of the battery 2 is almost stopped. When the timer circuit 67 stops the operation thereof, the inverter 68 outputs the high level signal. Here, the output voltage of the alternator 1 is lowered because it has controlled power generation. Therefore, the first comparator 65 provides an inverted output to turn on the power transistor 61. Thereby, power generation is started again. In this case, output voltage exceeds again the value  $V_{reg} + \alpha$ . The above cycle is repeated to delay the progress of damage of the defective area of the power supply line 8. Moreover, since chances of generating a high voltage can be reduced, electromagnetic damage to the electrical systems of a vehicle can also be controlled.

[First Modification]

The first modification of the first embodiment will be explained with reference to Fig. 2.

In this modification, the power transistor 61 is driven with the output signal of the AND gate 69, except for the pulse generator 70 of low duty ratio and the OR gate 71, from the voltage regulator 6 of the first embodiment.

If a certain failure is detected in the power supply line 8, namely when the timer circuit 67 is in the operative condition, the power transistor 61 is completely turned off and therefore

supply of the field current is stopped. The field current flowing into the field winding 5 rapidly attenuates because the magnetic energy thereof is converted to thermal energy with the resistance of the field winding 5 through the flywheel diode 62. Since the preset period of timer circuit 67 is longer than the time constant of the field winding 5, power generation is not started again until the field current disappears completely. Thereafter, when the timer circuit 67 stops operation, the inverter 68 outputs a high level signal. Here, the output voltage of the alternator 1 is lowered because it has stopped the power generation. Therefore, the first comparator 65 provides an inverted output to turn on the power transistor 61. Thereby, the power generation is started again. In this case, when output voltage exceeds  $V_{reg} + \alpha$ , the cycle explained above is repeated to delay progress of damage on the defective area of the power supply line 8. Moreover, chances for generating high voltage can be reduced, and damage on the electric systems of vehicle can be controlled.

[Second Modification]

Fig. 3 shows a second modification of the first embodiment.

In this modification, unlike the first modification, the full-waver rectifier 4 is formed of Zener diodes having the reverse breakdown characteristic to absorb the high voltage surge.

The voltage regulator 6 is provided with a filter 72 for detecting the peak value of output voltage of the armature winding 3, and this peak value is compared with a threshold value

V1, that is larger than the regulated voltage  $V_{reg}$ , and is smaller than the reverse breakdown voltage  $V_z$  of the Zener diode.

When a failure occurs in the power supply line 8, a high voltage surge exceeding the reverse breakdown voltage of the Zener diode is never outputted from the alternator 1. However, the larger the high voltage surge absorbed with the Zener diode is, the greater the thermal damage accumulated in the Zener diode becomes.

According to this modification, when a voltage exceeding  $V_1$  is generated in the armature winding 3, the second comparator 66 provides an inverted output to turn off the power transistor 61 after the magnetic energy accumulated in the field winding 5 is completely attenuated, power generation is started again. Therefore, since the heat generated in the Zener diode is sufficiently transferred to the external side, temperature rise due to the reverse breakdown of the Zener diode is eliminated. This process is shown in Fig. 7. Temperature rise occurs once due to the reverse current  $I$  of Zener diode caused by high voltage. Since power generation is immediately stopped, the reverse current  $I$  no longer continues. Therefore, thermal energy generated in the element is released to the external side via the structural members. After the timer circuit 67 stops operation, the reverse current  $I$  flows again but power generation is immediately stopped. As a result, the element temperature  $T$  reaches a value lower than the initial temperature  $T_0$ . This temperature  $T$  is of course never lower than the external temperature. Owing to such a control, thermal damage of the